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COMPARATIVE STUDY OF BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS WITH RESPECT TO GAS-PRODUCTION *

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The question of the differentiation of the bacillus of symptomatic anthrax from that of malignant edema often arises. The fact that both possess the ability to produce gas when grown in carbohydrate-containing media, suggested that this characteristic might be used in differentiation. A study of the literature revealed such a paucity of data in this field that further work seemed necessary.

In this communication attention has been confined largely to the production of carbon dioxid and hydrogen and to their ratios. Work has also been done on the production of hydrogen sulfid and on several other biochemical characteristics, such as the production of methyl mercaptan, indol, and acids, and the action on nitrates. This work will be the substance of a later report.

The sources of the various strains are recorded in Table 1. Attention was paid especially to the two organisms mentioned, but several allied organisms were included for the sake of comparison. A very active gas-producing strain of B. coli was used as a control.

Sugar-free broth was prepared by allowing an active strain of B. coli to grow in regular beef infusion for 18 hours. The medium was then boiled 20 minutes and filtered, and 2% Witte's peptone and 0.5% sodium chlorid added. It was then titrated and adjusted to a reaction neutral to phenolphthalein.[1] The medium was sterilized fractionally for 30 minutes at 100 C. on each of 3 successive days.

Control inoculations in this sugar-free broth were made with a strain of B. coli which produced large quantities of gas in media containing dextrose, levulose, galactose, arabinose, mannose, rhamnose, xylose, lactose, maltose, saccharose, raffinose, sorbite, dulcite, mannite, and salicin; and also with a strain of B. mucosus-capsulatus that produced gas in media containing dextrose, levulose, galactose, mannose, lactose, maltose, saccharose, dextrin, and glycerin. In these controls no gas was produced during 10 days' incubation.

This broth was then used as the bearer of the various carbohydrates. These were added in 1% proportion and the resulting media, in 250-c.c. flasks, were heated 30 minutes in flowing steam, filled into sterile fermentation tubes, heated

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* Received for publication October 18, 1916.

[1] Standard Methods of Water Analysis, 1912.

TABLE 1

The Sources of the Strains Studied

Organism and Strain No.		Source
B. anthracis-symptomatici	2	Blackleg vaccine from U. S. Dept. of Agriculture, Washington, D. C.
	3	An American commercial blackleg vaccine virus
	4	A tube of blackleg virus (desiccated blackleg meat) received from Dr. G. W. Dunphey, state veterinarian, Lansing, Mich.
	5	Culture from symptomatic anthrax, received from Dr. V. A. Moore, Cornell University, Ithaca, N. Y.
	6	A French commercial blackleg vaccine virus
	10	A French commercial blackleg vaccine virus
	12	An American commercial blackleg vaccine virus
	48	Culture received from an American commercial laboratory
	60	Culture received from Dr. F. G. Novy, University of Michigan, Ann Arbor
B. oedematis-maligni	421	Culture received from the culture bureau of the American Museum of Natural History, New York City
	485	Culture received from the culture bureau of the American Museum of Natural History, New York City
	558	Culture received from the culture bureau of the American Museum of Natural History, New York City
	560	Culture received from Dr. F. G. Novy
B. oedematis-maligni II	1	Culture received from Dr. Novy
B. botulinus	1	Culture received from Dr. Novy
Ghon-Sachs bacillus	1	Culture received from Dr. K. F. Meyer, University of California, Berkeley
B. coli (De Snoo)		Culture received from Dr. Poels, Holland state serum laboratory, Rotterdam

in the tubes for another 30 minutes in flowing steam, and then incubated 4 days to reveal contamination. It was found by this method that sterilization was accomplished with slight hydrolysis of the various carbohydrates.

Baseless fermentation tubes, holding 12 c.c. of media when filled to a convenient height, were used. These were readily handled in special racks holding 18 tubes each. They stood in such position that the closed arm was always upright and could not be jarred loose from this position during handling of the racks.

The following carbohydrates, alcohols, and glucosids[2] were used:

Monosaccharids—dextrose, levulose, galactose, arabinose, mannose, rhamnose, xylose.
Disaccharids—lactose, maltose, saccharose.
Trisaccharid—raffinose.
Polysaccharids—dextrin, inulin, glycogen, starch.
Alcohols—the trihydric, glycerin; the pentahydric, adonite; the hexahydrics, sorbite, dulcite, and mannite.
Glucosids—salicin, amygdalin, phlorizin.

The polysaccharids dissolved with some difficulty. Soluble starch, according to Lintner, was employed. The carbohydrates were of the best quality obtainable.

The experiment was made completely twice over, as indicated in Tables 2 and 3. In the first trial, as seed of the various strains, 4-day-old cultures in Martin's broth[3] were used. These strains had been carried as stock cultures in Martin's broth under hydrogen, the interval of transplant having been

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[2] Hawk, Physiological Chemistry, 1914, p. 25. Eyre, Technique of Bacteriology, 1913, p. 178.

[3] Besson, Bacteriology, Microbiology and Serum Therapy, 1913, p. 33.

6 days. In the second trial, the seed cultures had been trained for 2 generations in the plain sugar-free broth prepared. Otherwise, the conditions were maintained as nearly as possible the same in both experiments.

Inoculation of fermentation tubes was made by the pipet method, 4 drops of the sediment emulsion being used, which, in the case of the spore-bearers, contained enormous numbers of spores.

Readings were taken every 24 hours, and gas levels marked with waterproof hard-drying carbon ink. Readings were made for at least 11 consecutive days. Gas in the closed arm is indicated in the tables in percentages of total height of column. Less than 5% is designated + because amounts less than that can be estimated only approximately. Readings were made by means of a finely graduated gasometer at the back of the tube and to the bottom of the meniscus. Carbon dioxid was determined by absorption with 2% sodium-hydroxid solution.

In figuring out the so-called gas coefficients, the formula CO_2/H was used. This directs special attention to the carbon dioxid produced, since the resulting figure gives at a glance a comparative estimate of the carbon dioxid in proportion to the residual gas, which is largely hydrogen, tho there is probably some methane in it also.[4] The greater the factor, the greater the proportionate amount of carbon dioxid produced.

For all practical purposes the coefficients obtained with gas of less than 10% mean little, unless there is a decided reduction in volume when the carbon dioxid is absorbed. Even a slight reduction—1%—in the amount of gas in the closed arm is detectable and measurable, but most emphasis should be placed on the coefficients obtained from gas produced in larger amounts.

During the sodium-hydroxid treatment, reduction of the gas volume present, in the small as well as in the larger amounts, indicates the presence of carbon dioxid and is of value as suggesting the splitting up of carbohydrate material. In this experiment in which so-called sugar-free broth was used as control on the sugar media, gas was produced by the majority of the strains. In no case was there even a suggestion of reduction of volume during the sodium-hydroxid treatment. There was no carbon dioxid present, but the gas formed was explosive when mixed with air. In the first trial, conducted like the second except for the difference in seed cultures, the same strain of B. coli and several other strains produced no gas from the broth during 11 days' incubation. In the second trial, for which the seed used had been grown and trained (with some difficulty) in the sugar-free broth, colon bacilli, as well as the majority of the spore-bearing anaerobes, produced gas from

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[4] Besson, Bacteriology, Microbiology and Serum Therapy, 1913, p. 555.

TABLE 2

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Strain	Dextrose	Levulose	Galactose	Arabinose	Mannose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin	Inulin
Bacillus anthracis-symptomatici												
2	0 10 + 10 + 10 5 18 7 20 7 $x=\frac{10}{10}=1$	+ 22 7 22 10 25 12 25 17 25 20 $x=\frac{17}{8}=2.12$	+ 10 5 10 5 22 7 60 7 60 7 $x=\frac{5}{55}=0.09$	0 8 + 8 5 8 5 8 5 8 5 $x=\frac{3}{5}=0.6$	+ 10 5 10 5 10 7 35 7 35 10 $x=\frac{8}{27}=0.29$	+ 5 + 5 + 5 + 5 + 5 + 5 $x=\frac{2}{3}=0.67$	+ 12 + 12 5 12 7 12 7 12 10 $x=\frac{0}{12}=0$	0 20 5 20 10 20 12 20 15 28 20 $x=\frac{20}{8}=2.5$	0 10 5 10 7 10 10 10 10 10 10 $x=\frac{3}{7}=0.4$	0 5 + 5 5 7 5 7 5 7 5 $x=\frac{2}{5}=0.4$	0 10 + 10 5 10 7 10 10 10 10 $x=\frac{0}{10}=0$	25 30 27 30 30 30 30 30 30 30 30 $x=\frac{5}{25}=0.2$
3	+ 15 + 18 5 18 7 20 10 23 10 $x=\frac{18}{5}=3.6$	0 30 10 30 15 30 18 30 25 30 25 $x=\frac{20}{10}=2$	0 5 + 5 + 57 5 60 5 60 5 $x=\frac{8}{52}=0.15$	0 10 + 10 8 10 8 10 8 10 8 $x=\frac{5}{5}=1$	0 7 + 7 5 7 7 7 7 7 7 $x=\frac{2}{5}=0.4$	+ 5 + 5 + 5 + 5 5 5 5 $x=\frac{1}{4}=0.25$	0 7 + 7 5 7 5 7 5 7 5 $x=\frac{2}{5}=0.4$	0 43 7 50 15 55 20 45 25 62 25 $x=\frac{50}{12}=4.17$	0 8 + 8 5 8 7 8 7 8 7 $x=\frac{3}{5}=0.6$	0 5 + 5 5 10 5 10 5 10 5 $x=\frac{2}{8}=0.25$	0 + 0 + + + + + + + + $x=\frac{0}{+}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$
4	0 7 + 12 + 12 + 15 + 22 5 $x=\frac{15}{7}=2.14$	+ 8 + 8 + 8 5 8 7 8 7 $x=\frac{4}{4}=1.0$	+ 7 + 7 + 25 + 27 5 27 5 $x=\frac{7}{20}=0.35$	0 7 + 7 5 7 5 10 5 10 5 $x=\frac{3}{7}=0.43$	0 8 + 8 5 8 7 8 7 8 7 $x=\frac{3}{5}=0.6$	+ 10 5 10 7 10 7 10 8 10 8 $x=\frac{3}{7}=0.43$	0 7 + 7 + 7 + 7 + 7 + $x=\frac{2}{5}=0.4$	10 45 10 48 17 48 30 45 35 52 40 $x=\frac{40}{12}=3.5$	0 17 + 17 + 17 5 17 5 17 15 $x=\frac{4}{13}=0.3$	+ 12 10 12 12 12 12 12 12 12 12 $x=\frac{2}{10}=0.2$	0 8 + 8 + 8 5 8 5 8 5 $x=\frac{3}{5}=0.6$	+ 10 5 10 5 10 7 10 7 10 7 $x=\frac{2}{8}=0.25$
5	0 40 + 42 5 45 7 45 30 45 35 $x=\frac{28}{17}=1.65$	0 42 15 42 20 45 30 45 40 45 40 $x=\frac{35}{10}=3.5$	+ 8 7 8 7 8 7 10 7 10 7 $x=\frac{4}{6}=0.67$	0 15 10 15 12 15 15 15 15 15 15 $x=\frac{5}{10}=0.5$	0 7 + 7 + 7 + 7 5 7 5 $x=\frac{2}{5}=0.4$	+ 8 5 8 7 8 7 8 7 8 7 $x=\frac{0}{8}=0$	0 10 5 10 7 10 10 10 10 10 10 $x=\frac{2}{8}=0.25$	0 48 20 50 30 50 35 50 40 50 47 $x=\frac{37}{13}=2.85$	0 25 5 25 7 25 10 25 10 25 25 $x=\frac{5}{20}=0.25$	0 8 + 8 5 8 5 8 5 8 5 $x=\frac{0}{8}=0$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	+ 10 5 10 7 10 7 10 7 10 7 $x=\frac{2}{8}=0.25$
6	0 70 18 75 30 75 45 80 55 80 65 $x=\frac{60}{20}=3$	0 22 5 22 10 27 12 27 15 27 20 $x=\frac{19}{8}=2.37$	+ 12 10 12 10 12 10 13 10 13 10 $x=\frac{6}{7}=0.84$	0 5 + 5 + 5 + 7 + 7 5 $x=\frac{2}{5}=0.4$	+ 20 15 20 17 20 17 20 18 20 20 $x=\frac{7}{13}=0.53$	0 8 + 8 + 8 + 8 5 8 5 $x=\frac{2}{6}=0.33$	0 8 + 8 5 8 5 8 5 8 5 $x=\frac{1}{7}=0.14$	0 25 5 25 8 28 10 25 15 35 20 $x=\frac{25}{10}=2.5$	0 7 + 7 + 7 + 7 + 7 5 $x=\frac{2}{5}=0.4$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{0}{5}=0$	0 8 + 8 5 8 5 8 5 8 7 $x=\frac{3}{5}=0.6$	0 7 + 7 + 20 + 20 5 20 5 $x=\frac{5}{15}=0.33$
10	0 15 + 18 + 18 + 100 + 100 5 $x=\frac{20}{80}=0.25$	0 50 5 50 12 50 45 50 45 50 50 $x=\frac{23}{27}=0.85$	0 + ? + + + + + + + + $x=0$	0 7 + 7 5 7 5 7 5 7 5 $x=\frac{2}{5}=0.4$	+ 10 5 10 5 10 7 10 7 10 7 $x=\frac{2}{8}=0.25$	0 7 + 7 + 7 + 7 + 7 5 $x=\frac{2}{5}=0.4$	0 10 5 10 7 10 7 10 7 10 7 $x=\frac{3}{7}=0.43$	0 20 5 20 8 25 10 20 15 20 20 $x=\frac{12}{8}=1.5$	0 10 + 10 7 10 7 10 7 10 7 $x=\frac{0}{10}=0$	0 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	0 35 35 35 35 35 35 35 35 35 35 $x=\frac{2}{33}=0.06$	+ 7 5 7 7 63 7 63 7 63 7 $x=\frac{3}{60}=0.05$
12	0 5 + 5 + 5 + 95 + 95 + $x=\frac{10}{85}=0.12$	0 24 10 24 15 25 20 33 20 33 20 $x=\frac{18}{15}=1.2$	0 8 + 8 5 8 7 8 7 8 7 $x=\frac{3}{5}=0.6$	0 10 5 10 5 10 7 10 7 10 7 10 $x=\frac{3}{7}=0.43$	0 7 + 7 5 7 5 7 5 7 8 $x=\frac{2}{5}=0.4$	+ 7 + 7 5 7 5 7 5 7 5 $x=\frac{1}{6}=0.14$	0 30 + 30 5 30 5 30 5 30 5 $x=\frac{5}{25}=0.2$	0 25 7 25 10 25 15 25 20 25 25 $x=\frac{15}{10}=1.5$	+ 18 5 18 5 18 5 18 7 18 15 $x=\frac{3}{15}=0.2$	0 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 15 10 15 12 55 12 55 12 65 12 $x=\frac{15}{50}=0.3$

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* Readings made every 24 hours for 11 days. Amount of gas produced indicated in percentages. Less than 5% is designated +. $x = CO_2/H$.

Uninoculated control tubes of all media were negative throughout the 11 days' incubation.

TABLE 2.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Rhamnose	Salicin	Amygdalin	Phlorizin	Carbohydrate-free Broth
Bacillus anthracis-symptomatici											
0 5	0 5	0 8	+ 7	0 18	0 7	0 7	5 10	+ 25	+ 7	0 0	0 0
+ 5	0 5	+ 8	+ 7	7 18	+ 7	0 7	8 10	15 27	+ 7	0 0	0 0
+ 5	+ 5	+ 10	5 7	10 23	5 7	5 7	10 10	17 27	5 7	0 0	0 0
+ 5	5 5	+ 42	5 7	10 23	5 7	5 7	10 10	20 27	5 7	0 0	0 0
5 5	5 5	5 42	5 7	13 23	5 7	7 7	10 10	22 27	7 7	0 0	0 0
5	5	5	5	15	5	7	10	25	7	0	0
$x=\frac{0}{5}=0$	$x=\frac{0}{5}=0$	$x=\frac{2}{40}=0.05$	$x=\frac{1}{6}=0.16$	$x=\frac{10}{13}=0.77$	$x=\frac{2}{5}=0.4$	$x=\frac{1}{6}=0.16$	$x=\frac{1}{9}=0.11$	$x=\frac{7}{20}=0.34$	$x=\frac{2}{5}=0.4$	$x=0$	$x=0$
0 5	0 5	0 15	0 7	0 23	0 7	0 8	0 7	+ 32	+ 7	0 0	0 0
+ 5	+ 5	10 15	+ 7	8 23	+ 7	0 8	+ 7	20 35	5 10	0 0	0 0
+ 5	5 5	12 18	5 7	12 28	5 7	5 8	5 7	25 35	7 10	0 0	0 0
+ 5	5 5	12 15	5 7	15 28	5 7	7 8	5 7	30 35	7 10	0 0	0 0
5 5	5 5	12 15	5 7	17 28	5 7	7 8	7 7	30 35	7 10	0 0	0 0
5	5	12	5	18	5	8	7	32	7	0	0
$x=\frac{0}{5}=0$	$x=\frac{0}{5}=0$	$x=\frac{3}{12}=0.25$	$x=\frac{1}{6}=0.16$	$x=\frac{13}{15}=0.87$	$x=\frac{1}{6}=0.16$	$x=\frac{0}{8}=0$	$x=\frac{0}{7}=0$	$x=\frac{11}{24}=0.46$	$x=\frac{0}{10}=0$	$x=0$	$x=0$
0 5	0 10	0 12	0 7	7 25	0 7	0 7	+ 5	0 30	0 5	0 0	0 0
+ 5	5 10	7 12	5 7	10 25	+ 7	0 10	+ 5	15 32	+ 5	0 0	0 0
+ 5	7 10	8 12	7 7	15 27	5 7	5 10	5 5	20 32	5 5	0 0	0 0
+ 5	7 10	10 12	7 7	18 27	7 7	7 10	5 5	25 32	5 5	0 0	0 0
5 5	10 10	10 12	7 7	20 27	7 7	7	5 5	25 32	5 5	0 0	0 0
5	10	10	7	22	7	7	5	30	5	0	0
$x=\frac{0}{5}=0$	$x=\frac{2}{8}=0.25$	$x=\frac{2}{10}=0.2$	$x=\frac{1}{6}=0.16$	$x=\frac{13}{14}=0.9$	$x=\frac{0}{7}=0$	$x=\frac{1}{9}=0.11$	$x=\frac{0}{5}=0$	$x=\frac{8}{24}=0.33$	$x=\frac{0}{5}=0$	$x=0$	$x=0$
+ 5	+ 8	0 8	+ 8	0 15	0 7	0 11	+ 5	+ 35	+ 8	0 0	0 0
+ 5	5 10	+ 8	5 8	5 15	+ 7	0 11	+ 5	20 38	+ 8	0 0	0 0
+ 5	7 10	5 8	5 8	7 20	5 7	8 11	5 5	25 38	7 8	0 0	0 0
5 5	7 10	7 8	5 8	10 20	6 7	10 11	5 5	28 38	7 8	0 0	0 0
5 5	8 10	7 8	5 8	12 20	6 7	10 11	5 5	30 38	7 8	0 0	0 0
5	8	7	5	14	6	10	5	35	7	0	0
$x=\frac{0}{5}=0$	$x=\frac{1}{9}=0.11$	$x=\frac{0}{8}=0$	$x=\frac{1}{7}=0.14$	$x=\frac{10}{10}=1$	$x=\frac{0}{7}=0$	$x=\frac{1}{10}=0.1$	$x=\frac{0}{5}=0$	$x=\frac{13}{25}=0.52$	$x=\frac{1}{7}=0.14$	$x=0$	$x=0$
+ 5	0 8	0 10	0 10	+ 48	0 7	+ 7	0 7	0 5	0 7	0 0	0 +
+ 5	+ 9	+ 10	+ 10	12 48	+ 7	+ 7	+ 7	+ 8	+ 7	0 0	0 +
+ 5	5 9	+ 10	8 10	13 70	5 7	5 7	7 7	+ 8	+ 7	0 0	0 +
5 5	5 9	5 10	8 10	18 70	6 7	7 7	7 7	+ 8	5 7	0 0	0 +
5 5	7 9	5 10	10 10	22 70	6 7	7 7	7 7	5 8	7 7	0 0	0 +
5	8	5	10	30	6	7	7	5	7	0	+
$x=\frac{0}{5}=0$	$x=\frac{1}{8}=0.13$	$x=\frac{2}{8}=0.25$	$x=\frac{0}{10}=0$	$x=\frac{55}{15}=3.67$	$x=\frac{0}{7}=0$	$x=\frac{1}{6}=0.6$	$x=\frac{0}{7}=0$	$x=\frac{0}{8}=0$	$x=\frac{0}{7}=0$	$x=0$	$x=0$
0 5	0 7	0 17	+ 7	0 15	0 7	0 9	0 10	0 20	0 7	0 0	0 0
+ 5	+ 8	10 17	+ 7	5 15	+ 7	0 9	8 10	5 22	+ 7	0 0	0 0
5 5	+ 8	15 17	5 7	7 18	5 7	5 9	10 10	10 22	5 7	0 0	0 +
5 5	5 8	15 17	5 7	10 18	7 7	7 9	10 10	12 22	5 7	0 0	0 +
5 5	7 8	15 17	7 7	11 18	7 7	9 9	10 10	20 22	7 7	0 0	0 +
5	7	15	7	12	7	9	10	20	7	0	
$x=\frac{0}{5}=0$	$x=\frac{0}{8}=0$	$x=\frac{5}{12}=0.42$	$x=\frac{0}{7}=0$	$x=\frac{8}{10}=0.8$	$x=\frac{0}{7}=0$	$x=\frac{0}{9}=0$	$x=\frac{0}{10}=0$	$x=\frac{2}{20}=0.1$	$x=\frac{0}{7}=0$	$x=0$	$x=0$
0 5	0 7	0 8	0 8	+ 10	0 7	0 7	0 8	0 20	0 10	0 0	0 0
+ 5	+ 8	+ 8	+ 8	+ 10	+ 7	0 7	+ 8	17 20	+ 10	0 0	0 0
+ 5	5 8	+ 8	5 8	5 12	5 7	+ 7	5 8	20 20	7 10	0 0	0 0
+ 5	5 8	+ 8	5 8	5 12	5 7	5 7	5 8	20 20	7 10	0 0	0 0
5 5	7 8	5 8	5 8	8 12	5 7	7 7	8 8	20 20	7 10	0 0	0 0
5	7	5	5	10	5	7	8	20	7	0	0
$x=\frac{0}{5}=0$	$x=\frac{0}{8}=0$	$x=\frac{2}{6}=0.33$	$x=\frac{2}{6}=0.33$	$x=\frac{3}{9}=0.25$	$x=\frac{1}{6}=0.16$	$x=\frac{0}{7}=0$	$x=\frac{0}{8}=0$	$x=\frac{0}{20}=0$	$x=\frac{0}{10}=0$	$x=0$	$x=0$

TABLE 2.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Strain	Dextrose	Levulose	Galactose	Arabinose	Mannose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin	Inulin
Bacillus anthracis-symptomatici												
48	0 + + 5 + 5 + 7 + 7 + $x=\frac{0}{7}=0$	+ 35 13 35 15 40 20 55 27 55 30 $x=\frac{25}{30}=0.83$	0 5 + 5 + 5 + 13 5 13 5 $x=\frac{3}{10}=0.3$	0 8 + 8 5 8 5 8 5 8 5 $x=\frac{3}{5}=0.6$	0 12 + 12 10 12 12 12 12 12 12 $x=\frac{2}{10}=0.2$	+ 13 + 13 5 13 5 13 5 13 5 $x=\frac{8}{5}=1.6$	0 15 + 15 5 15 5 15 5 15 5 $x=\frac{0}{15}=0$	0 22 + 25 7 28 10 22 15 22 20 $x=\frac{17}{5}=3.4$	+ 15 13 15 15 15 15 13 15 13 15 $x=\frac{3}{10}=0.3$	+ 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	+ 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 8 + 8 5 8 5 8 5 8 5 $x=\frac{0}{8}=0$
60	+ 47 12 47 23 50 30 50 38 50 42 $x=\frac{43}{7}=6.14$	5 52 12 52 20 55 30 55 38 55 42 $x=\frac{45}{10}=4.5$	5 10 5 10 8 10 8 10 10 10 10 $x=\frac{2}{8}=0.25$	+ 8 5 10 6 10 7 10 7 10 8 $x=\frac{2}{8}=0.25$	+ 7 + 7 5 7 7 7 7 7 7 $x=\frac{1}{6}=0.16$	+ 7 + 7 + 7 + 7 + 7 5 $x=\frac{1}{6}=0.16$	+ 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	+ 32 53 67 Broken	+ 8 + 8 7 8 8 8 8 8 8 $x=\frac{1}{7}=0.14$	+ 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 + + + + + + 7 + 7 + $x=\frac{0}{7}=0$	+ 8 + 8 7 8 8 8 8 8 8 $x=\frac{0}{8}=0$
Bacillus oedematis-maligni, I												
421	+ 25 10 25 15 25 20 25 20 25 20 $x=\frac{17}{8}=2.12$	+ 28 12 28 20 28 25 28 25 28 25 $x=\frac{18}{10}=1.8$	0 5 + 5 + 5 + 7 + 7 5 $x=\frac{2}{5}=0.4$	0 10 0 10 + 10 5 58 7 58 10 $x=\frac{3}{55}=0.05$	0 15 + 15 10 15 12 15 12 15 15 $x=\frac{3}{12}=0.25$	0 7 + 7 + 7 5 7 7 7 7 $x=\frac{0}{7}=0$	0 15 + 15 7 15 10 15 10 15 10 $x=\frac{3}{12}=0.25$	0 40 17 42 25 45 30 45 35 45 40 $x=\frac{30}{15}=2$	0 7 + 7 + 10 + 12 + 20 5 20 $x=\frac{5}{15}=0.33$	0 8 + 8 5 8 5 8 5 5 $x=\frac{0}{8}=0$	0 5 0 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	+ 10 + 10 5 10 5 10 8 10 8 $x=\frac{5}{5}=1$
485	0 15 5 15 8 15 12 18 12 18 15 $x=\frac{12}{6}=2$	+ 45 17 45 30 50 35 50 40 50 45 $x=\frac{40}{10}=4$	0 7 + 7 5 7 5 7 5 7 5 $x=\frac{2}{5}=0.4$	0 5 0 5 + 5 5 8 5 8 5 $x=\frac{0}{8}=0$	0 12 5 12 10 12 10 12 10 12 10 $x=\frac{4}{8}=0.5$	+ 9 5 9 5 9 7 9 9 9 9 $x=\frac{0}{9}=0$	0 10 + 10 5 10 5 10 5 10 5 $x=\frac{0}{10}=0$	0 28 10 30 15 30 20 30 22 30 25 $x=\frac{20}{10}=2$	0 10 0 10 + 10 + 10 + 10 5 $x=\frac{0}{10}=0$	0 7 5 7 7 7 7 7 7 7 $x=\frac{0}{7}=0$	0 28 + 28 + 28 + 28 + 28 25 $x=\frac{4}{24}=0.17$	0 + + + + + + + + + + $x=\frac{0}{+}=0$
558	+ 14 5 15 5 17 10 20 10 20 10 $x=\frac{10}{10}=1$	0 17 + 17 5 18 10 22 12 22 15 $x=\frac{17}{5}=3.4$	0 + 0 + + + + + + 4 + $x=\frac{2}{2}=1$	0 10 5 10 5 10 5 10 7 10 7 $x=\frac{2}{8}=0.25$	0 10 5 10 5 10 10 10 10 10 10 $x=\frac{2}{8}=0.25$	+ 5 + 5 + 5 + 5 5 5 5 $x=\frac{1}{4}=0.25$	+ 5 + 7 + 10 5 13 5 13 5 $x=\frac{0}{13}=0$	+ 30 10 30 20 30 22 30 25 30 28 $x=\frac{20}{10}=2$	0 7 + 7 + 8 + 10 5 10 5 $x=\frac{0}{10}=0$	0 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	0 7 0 7 + 7 5 7 5 7 5 $x=\frac{2}{5}=0.4$	0 + 0 + + + + + + + + $x=\frac{0}{+}=0$
560	+ 8 5 8 5 8 7 8 8 8 8 $x=\frac{2}{6}=0.4$	0 24 5 28 8 30 12 33 15 33 20 $x=\frac{28}{5}=5.6$	5 17 12 17 15 17 15 17 15 17 16 $x=\frac{5}{12}=0.42$	0 + + + + + + + + + + $x=\frac{0}{+}=0$	+ 20 10 20 13 20 16 20 18 20 20 $x=\frac{5}{15}=0.33$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 8 + 8 + 8 7 8 7 8 7 $x=\frac{1}{7}=0.14$	0 20 5 20 10 20 13 20 16 20 18 $x=\frac{13}{7}=1.9$	7 18 10 18 15 18 15 18 15 18 17 $x=\frac{3}{15}=0.2$	0 5 + 5 + 5 5 5 5 5 5 $x=\frac{0}{5}=0$	+ + + 5 + 5 + 8 + 8 + $x=\frac{3}{5}=0.6$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$

TABLE 2.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Rhamnose	Salicin	Amygdalin	Phlorizin	Carbohydrate-free Broth
Bacillus anthracis-symptomatici											
0 5	0 13	0 8	+ 8	+ 20	0 7	0 10	+ 5	0 15	0 8	0 0	0 0
+ 5	8 15	+ 8	+ 8	12 20	+ 7	0 10	+ 5	5 15	+ 8	0 0	0 0
5 5	12 15	5 8	5 8	13 23	5 7	5 10	+ 5	7 15	5 8	0 0	0 0
5 5	12 15	5 8	5 8	15 23	5 7	7 10	5 5	10 15	5 8	0 0	0 0
5 5	13 15	5 8	5 8	16 23	5 7	10 10	5 5	12 15	8 8	0 0	0 0
5	13	5	5	20	5	10	5	15	8	0	0
$x=\frac{0}{5}=0$	$x=\frac{2}{13}=0.15$	$x=\frac{0}{8}=0$	$x=\frac{0}{8}=0$	$x=\frac{8}{15}=0.53$	$x=\frac{0}{7}=0$	$x=\frac{0}{10}=0$	$x=\frac{0}{5}=0$	$x=\frac{3}{12}=0.25$	$x=\frac{0}{8}=0$	$x=0$	$x=0$
+ 5	0 7	+ 10	+ 5	+ 12	0 8	0 15	+ 5	+ 19	0 5	0 0	0 0
+ 5	+ 8	7 10	5 5	+ 13	+ 8	8 15	+ 5	8 19	+ 8	0 0	0 0
+ 5	5 8	8 10	5 5	5 15	5 8	13 15	+ 5	12 20	5 8	0 +	0 0
+ 5	5 8	8 10	5 5	5 12	5 8	14 15	5 5	15 20	5 5	0 +	0 +
+ 5	7 8	10 10	5 5	9 12	5 8	15 15	5 5	15 20	5 5	0 +	0 +
5	7	10	5	10	5	15	5	15	5	0	0
$x=\frac{0}{5}=0$	$x=\frac{0}{8}=0$	$x=\frac{2}{8}=0.25$	$x=\frac{1}{4}=0.25$	$x=\frac{4}{8}=0.5$	$x=\frac{0}{8}=0$	$x=\frac{5}{10}=0.5$	$x=\frac{0}{5}=0$	$x=\frac{4}{16}=0.25$	$x=\frac{0}{5}=0$	$x=\frac{0}{+}=0$	$x=0$
Bacillus oedematis-maligni, I											
0 +	0 8	0 17	0 10	15 30	0 9	0 10	0 15	0 12	0 5	0 0	0 +
+ +	+ 8	0 17	+ 10	20 30	+ 9	0 12	+ 15	0 15	+ 8	0 0	0 +
+ +	+ 8	+ 17	7 10	23 32	+ 9	+ 12	12 15	0 20	+ 8	0 +	+ +
+ +	5 8	5 17	7 10	23 32	5 9	7 12	12 15	+ 20	5 8	0 +	+ +
+ 5	6 8	12 17	8 10	27 32	5 9	10 12	12 15	5 20	5 8	0 +	+ +
+	8	15	10	28	5	10	15	10	5	0	+
$x=\frac{0}{5}=0$	$x=\frac{0}{8}=0$	$x=\frac{3}{14}=0,21$	$x=\frac{2}{8}=0.25$	$x=\frac{12}{20}=0.6$	$x=\frac{0}{9}=0$	$x=\frac{0}{12}=0$	$x=\frac{1}{14}=0.07$	$x=\frac{3}{17}=0.18$	$x=\frac{0}{8}=0$	$x=\frac{0}{+}=0$	$x=0$
0 +	+ 8	0 35	0 10	+ 10	0 10	0 8	+ 5	0 20	0 5	0 0	0 +
+ +	+ 9	5 35	5 10	+ 10	5 10	0 8	+ 5	5 20	+ 7	0 0	0 +
+ +	5 9	15 40	8 10	5 13	7 10	5 8	5 5	15 22	+ 7	0 +	0 +
+ +	5 9	20 40	8 10	5 10	8 10	5 8	5 5	18 22	5 5	0 +	+ +
+ 5	7 9	28 40	10 10	8 10	8 10	7 8	5 5	20 22	5 5	0 +	+ +
+	8	30	10	10	8	7	5	20	5	0	+
$x=\frac{0}{5}=0$	$x=\frac{2}{7}=0.28$	$x=\frac{18}{22}=0.82$	$x=\frac{0}{10}=0$	$x=\frac{2}{8}=0.25$	$x=\frac{0}{10}=0$	$x=\frac{0}{8}=0$	$x=\frac{0}{5}=0$	$x=\frac{2}{20}=0.1$	$x=\frac{0}{5}=0$	$x=\frac{0}{+}=0$	$x=0$
+ 5	+ 13	0 10	+ 9	0 10	0 7	0 6	+ 5	0 27	+ 5	0 0	0 0
+ 5	10 13	+ 10	5 9	+ 10	+ 7	0 6	+ 5	10 27	+ 5	0 0	0 +
+ 5	12 13	+ 18	5 9	5 10	5 7	+ 6	+ 5	20 27	5 5	0 0	0 +
+ 5	12 13	5 18	5 9	5 10	5 7	5 6	+ 5	25 27	5 5	0 0	0 +
+ 5	13 13	5 18	5 9	8 10	5 7	6 6	5 5	27 27	5 5	0 0	0 +
+	13	5	5	8	5	6	5	27	5	0	0
$x=\frac{0}{5}=0$	$x=\frac{0}{13}=0$	$x=\frac{8}{10}=0.8$	$x=\frac{0}{9}=0$	$x=\frac{0}{10}=0$	$x=\frac{0}{7}=0$	$x=\frac{0}{6}=0$	$x=\frac{0}{5}=0$	$x=\frac{10}{17}=0.58$	$x=\frac{0}{5}=0$	$x=0$	$x=0$
0 +	0 8	0 8	0 5	0 8	+ 7	0 5	+ 5	0 25	0 7	0 0	0 0
+ +	+ 8	+ 8	+ 5	+ 10	+ 7	0 5	+ 5	+ 25	+ 7	0 0	0 0
+ +	5 8	+ 10	5 7	5 12	5 7	+ 9	+ 10	15 25	5 7	0 0	0 0
+ +	5 8	+ 10	5 7	5 12	5 7	5 9	5	17	5 7	0 0	0 0
+ +	8 8	+ 10	5	7 12	5 7	5 9	5	22	5 7	0 0	0 0
+	8	8	5	8	5	5	5	25	5	0	0
$x=\frac{0}{3}=0$	$x=\frac{1}{7}=0.14$	$x=\frac{4}{6}=0.67$	$x=\frac{1}{6}=0.16$	$x=\frac{5}{7}=0.7$	$x=\frac{0}{7}=0$	$x=\frac{0}{9}=0$	$x=\frac{0}{10}=0$	$x=\frac{5}{20}=0.25$	$x=\frac{0}{7}=0$	$x=0$	$x=0$

TABLE 2.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Dextrose	Levulose	Galactose	Arabinose	Mannose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin	Inulin
Bacillus oedematis-maligni, II (Novy)											
+ 16	+ 28	+ 10	+ 8	+ 8	+ 5	+ 7	+ 32	+ 15	0 5	+ 5	+ 5
7 16	5 30	7 10	+ 8	5 8	+ 5	5 7	10 32	5 15	+ 5	+ 5	+ 5
12 16	10 30	8 10	7 10	7 12	+ 5	6 7	20 37	10 15	+ 5	+ 5	+ 5
14 16	17 32	8 10	7 10	7 48	+ 5	7 7	27 37	12 15	+ 5	5 5	5 8
15 16	23 32	10 10	8 10	8 48	+ 5	7 7	32 37	13 15	5 5	5 5	5 8
16	28	10	8	8	5	7	32	10	5	5	5
$x=\frac{11}{5}=2.2$	$x=\frac{24}{8}=3$	$x=\frac{2}{8}=0.25$	$x=\frac{2}{8}=0.25$	$x=\frac{8}{40}=0.2$	$x=\frac{2}{3}=0.67$	$x=\frac{0}{7}=0$	$x=\frac{27}{10}=2.7$	$x=\frac{5}{10}=0.5$	$x=\frac{0}{5}=0$	$x=\frac{0}{5}=0$	$x=\frac{0}{8}=0$
B. botulinus											
+ 5	0 11	0 +	0 5	0 5	0 5	7 12	+ 13	+ 10	0 5	+ 5	0 +
+ 5	+ 11	+ +	+ 5	+ 5	+ 5	7 12	5 13	+ 15	+ 5	+ 5	+ +
+ 7	5 11	+ +	+ 5	+ 5	+ 5	8 15	8 13	7 20	+ 5	+ 10	+ 5
+ 7	7 14	+ +	+ 5	+ 5	+ 5	10 15	10 13	8 28	5 5	+ 10	+ 5
+ 7	8 14	+ +	+ 5	5 5	+ 5	10 15	12 13	10 28	5 5	+ 10	+ 5
5	8	+	+	5	5	12	13	10	5	5	+
$x=\frac{2}{5}=0.4$	$x=\frac{9}{5}=1.8$	$x=\frac{0}{+}=0$	$x=\frac{1}{4}=0.25$	$x=\frac{1}{4}=0.25$	$x=\frac{2}{3}=0.67$	$x=\frac{2}{13}=0.15$	$x=\frac{10}{3}=3.33$	$x=\frac{16}{12}=1.33$	$x=\frac{0}{5}=0$	$x=\frac{0}{10}=0$	$x=\frac{0}{5}=0$
Ghon-Sachs bacillus											
0 65	0 10	0 25	0 10	0 0	0 8	0 20	0 12	0 7	0 0	0 12	0 8
0 65	0 10	0 25	+ 10	0 0	+ 8	0 20	0 12	0 7	0 0	0 12	0 8
0 65	? 13	0 30	5 10	0 0	5 8	7 20	? 15	0 32	0 0	0 12	0 8
15 63	+ 13	+ 30	5 100	0 15	5 8	10 20	+ 12	0 32	0 0	+ 12	+ 20
55 63	5 13	10 30	7 100	0 15	8 8	12 20	5 15	+ 32	0 0	10 12	5 20
65	7	17	7	0	8	15	10	+	0	10	5
$x=\frac{21}{42}=0.5$	$x=\frac{0}{13}=0$	$x=\frac{5}{25}=0.2$	$x=\frac{0}{100}=0$	$x=\frac{3}{12}=0.25$	$x=\frac{0}{8}=0$	$x=\frac{0}{20}=0$	$x=\frac{0}{15}=0$	$x=\frac{0}{32}=0$	$x=0$	$x=\frac{0}{12}=0$	$x=\frac{0}{20}=0$
B. coli (control)											
72 67	45 50	15 65	45 55	70 70	35 82	55 70	+ 80	30 63	50 87	0 32	0 0
75 67	55 50	50 65	55 55	75 70	52 85	68 70	40 80	53 63	70 87	0 32	0 0
75 67	58 50	60 65	60 55	78 70	60 85	70 70	70 80	65 63	78 87	+ 35	0 0
75 65	58 50	65 65	60 53	75 70	68 85	70 70	75 80	70 65	82 87	5 32	0 0
75 65	58 50	65 65	60 53	75 70	80 85	70 70	75 80	70 65	82 87	10 32	0 0
75	58	65	60	72	80	70	75	72	82	30	0
$x=\frac{15}{50}=0.3$	$x=\frac{15}{35}=0.43$	$x=\frac{20}{45}=0.44$	$x=\frac{13}{40}=0.33$	$x=\frac{23}{47}=0.5$	$x=\frac{45}{40}=1.13$	$x=\frac{25}{45}=0.55$	$x=\frac{30}{50}=0.6$	$x=\frac{20}{45}=0.44$	$x=\frac{44}{43}=1$	$x=\frac{2}{30}=0.07$	$x=0$

TABLE 2.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Rhamnose	Salicin	Amygdalin	Phlorizin	Carbohydrate-free Broth
Bacillus oedematis-maligni, II (Novy)											
0 5	0 8	10 30	0 7	5 18	0 7	0 6	0 5	+ 12	+ 5	0 0	0 0
+ 5	+ 8	15 30	+ 7	7 20	+ 7	0 6	+ 5	5 12	+ 5	0 0	0 0
+ 5	5 8	22 32	5 7	10 20	5 7	+ 6	+ 5	7 12	5 5	0 0	0 0
+ 5	7 8	25 32	5 7	10 20	5 7	5 6	+ 5	8 12	5 5	0 0	0 0
+ 5	8 8	28 32	5 7	13 20	5 7	6 6	+ 5	10 12	5 5	0 0	0 0
5	8	30	5	15	5	6	5	10	5	0	0
$x=\frac{0}{5}=0$	$x=\frac{1}{7}=0.14$	$x=\frac{15}{17}=0.9$	$x=\frac{0}{7}=0$	$x=\frac{10}{10}=1$	$x=\frac{0}{7}=0$	$x=\frac{0}{6}=0$	$x=\frac{0}{5}=0$	$x=\frac{2}{10}=0.2$	$x=\frac{0}{5}=0$	$x=0$	$x=0$
B. botulinus											
0 +	0 +	0 28	0 5	+ 18	0 6	0 5	0 5	+ 20	0 5	0 0	0 0
+ +	+ +	7 30	+ 5	5 21	+ 6	0 5	+ 5	10 20	+ 5	0 0	0 0
+ +	+ +	12 32	5 5	7 22	5 6	+ 5	+ 5	15 20	+ 5	0 0	0 0
+ +	+ +	15 35	5 5	10 22	5 6	+ 5	+ 5	15 22	+ 5	0 0	0 0
+ +	+ +	20 35	5 5	12 22	5 6	5 5	+ 5	18 22	5 5	0 0	0 0
+	+	25	5	15	5	5	5	20	5	0	0
$x=\frac{0}{3}=0$	$x=\frac{0}{+}=0$	$x=\frac{18}{17}=1.06$	$x=\frac{2}{3}=0.67$	$x=\frac{14}{8}=1.75$	$x=\frac{0}{6}=0$	$x=\frac{0}{5}=0$	$x=\frac{0}{5}=0$	$x=\frac{5}{17}=0.3$	$x=\frac{0}{5}=0$	$x=0$	$x=0$
Ghon-Sachs bacillus											
+ 10	0 0	0 8	0 8	0 0	0 7	0 0	0 10	0 7	0 0	0 0	0 0
8 10	0 0	0 15	0 8	0 0	0 7	0 5	+ 10	0 10	0 0	0 0	0 0
10 11	0 0	0 17	0 8	0 0	+ 7	0 5	7 10	+ 37	0 0	0 0	0 0
10 11	0 0	0 17	0 8	0 0	5 7	0 5	7 10	5 37	0 0	0 0	0 0
10 11	0 0	+ 17	+ 8	0 0	5 7	0 5	8 10	5 37	0 0	0 0	0 0
10	0	5	8	0	5	0	10	7	0	0	0
$x=\frac{0}{11}=0$	$x=0$	$x=\frac{2}{15}=0.13$	$x=\frac{0}{8}=0$	$x=0$	$x=\frac{0}{7}=0$	$x=\frac{0}{5}=0$	$=\frac{0}{10}=0$	$=\frac{2}{35}=0.0$	$x=0$	$x=0$	$x=0$
B. coli (control)											
0 +	0 +	0 0	0 5	52 83	0 11	37 70	27 57	0 55	0 5	0 +	Negative throughout
+ +	+ +	0 0	+ 5	82 80	+ 11	52 70	47 60	+ 55	+ 8	0 +	
+ +	+ +	0 0	+ 5	90 80	5 12	60 75	50 60	47 55	+ 8	+ +	
+ +	+ +	0 0	+ 5	92 70	8 12	65 75	55 60	55 55	+ 8	+ +	
+ +	+ +	0 0	5 5	88 70	10 12	70 70	57 60	55 55	5 8	+ 4	
+	+	0	5	83	10	70	57	55	5	+	
$x=\frac{0}{4}=0$	$x=\frac{0}{+}=0$	$x=0$	$x=\frac{0}{5}=0$	$x=\frac{28}{42}=0.67$	$x=\frac{6}{6}=1$	$x=\frac{30}{40}=0.75$	$x=\frac{30}{30}=1$	$x=\frac{5}{50}=0.1$	$x=\frac{2}{6}=0.33$	$x=\frac{0}{4}=0$	

TABLE 3

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Strain	Dextrose	Levulose	Galactose	Arabinose	Mannose	Rhamnose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin
B. anthracis-symptomatici												
2	0 20 + 22 7 25 11 27 14 30 18 $x=\frac{15}{15}=1$	+ 62 25 65 40 66 50 69 55 69 60 $x=\frac{49}{20}=2.45$	0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	0 13 7 14 11 14 12 14 12 14 13 $x=\frac{4}{10}=0.4$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{0}{5}=0$	0 10 + 12 7 12 8 12 10 12 10 $x=\frac{4}{8}=0.5$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 38 10 42 18 45 24 48 29 48 35 $x=\frac{36}{12}=3$	0 + + + + + + + + 5 + $x=\frac{0}{5}=0$	0 + 0 + + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 5 0 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$
3	0 46 11 50 22 51 32 52 37 52 43 $x=\frac{40}{12}=3.33$	+ 48 12 55 25 58 33 63 37 62 43 $x=\frac{50}{12}=4.17$	0 5 + 5 + 5 + 6 + 6 5 $x=\frac{1}{5}=0.2$	0 5 + 7 + 7 + 8 5 8 5 $x=\frac{4}{4}=1$	8 22 15 22 18 22 20 22 21 22 21 $x=\frac{8}{14}=0.57$	0 8 + 8 7 8 7 8 8 8 8 $x=\frac{0}{8}=0$	0 7 + 8 5 8 5 8 7 8 7 $x=\frac{2}{6}=0.33$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{0}{5}=0$	0 50 11 50 25 50 35 52 40 50 46 $x=\frac{37}{13}=3$	0 10 0 10 + 10 8 11 10 11 10 $x=\frac{2}{9}=0.22$	0 7 0 7 0 7 + 7 5 7 5 $x=\frac{0}{7}=0$	0 + 0 + 0 + + + + + + $x=\frac{0}{+}=0$
4	+ 60 15 60 30 60 40 60 50 60 57 $x=\frac{40}{20}=2$	+ 38 14 42 20 45 27 49 30 50 35 $x=\frac{36}{14}=2.57$	0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 6 + 6 + 6 5 6 5 6 5 $x=\frac{1}{5}=0.2$	0 9 + 9 5 9 7 9 8 9 8 $x=\frac{4}{5}=0.8$	0 10 + 10 9 10 9 10 10 10 10 $x=\frac{1}{9}=0.11$	0 6 + 7 + 7 5 7 6 7 6 $x=\frac{2}{5}=0.4$	0 7 + 7 5 7 5 7 7 7 7 7 $x=\frac{1}{6}=0.17$	15 62 28 63 43 64 54 65 58 65 60 $x=\frac{43}{22}=2$	0 11 + 11 10 12 10 12 10 12 11 $x=\frac{2}{10}=0.2$	0 + + 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	0 7 0 7 + 7 5 7 5 7 5 $x=\frac{0}{7}=0$
5	+ 32 15 32 22 33 27 33 50 33 31 $x=\frac{23}{10}=2.3$	+ 82 18 33 23 33 28 34 30 34 30 $x=\frac{21}{13}=1.61$	+ 16 13 17 15 17 15 17 15 17 15 $x=\frac{4}{13}=0.3$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{1}{4}=0.25$	0 10 + 10 7 10 8 10 8 10 8 $x=\frac{2}{8}=0.25$	0 8 + 9 7 9 7 9 8 9 8 $x=\frac{1}{8}=0.13$	0 7 + 8 + 8 5 8 7 8 7 $x=\frac{2}{6}=0.33$	0 7 + 7 5 7 5 7 7 7 7 $x=\frac{1}{6}=0.17$	0 45 20 45 30 45 37 47 40 46 42 $x=\frac{28}{18}=1.55$	0 15 0 15 10 15 13 15 13 15 13 $x=\frac{3}{12}=0.25$	+ 6 + 6 5 6 5 6 6 6 6 $x=\frac{1}{5}=0.2$	0 0 0 0 0 0 0 5 0 5 0 $x=\frac{0}{5}=0$
6	8 41 15 45 21 50 27 58 32 55 38 55 $x=\frac{42}{13}=3.2$	+ 75 17 80 30 80 47 76 60 76 70 $x=\frac{54}{22}=2.45$	+ 10 7 11 8 11 10 12 10 12 10 $x=\frac{4}{8}=0.5$	0 10 5 10 8 10 8 10 9 10 9 $x=\frac{1}{9}=0.11$	0 12 8 12 10 13 11 13 11 13 13 $x=\frac{3}{10}=0.3$	0 7 + 8 + 10 6 10 6 10 7 $x=\frac{0}{10}=0$	0 10 + 11 + 11 6 11 8 11 8 $x=\frac{5}{6}=0.83$	0 11 8 11 9 11 10 11 10 11 10 $x=\frac{1}{10}=0.1$	0 61 + 61 22 61 37 61 54 61 60 $x=\frac{44}{17}=2.6$	0 6 + 6 + 6 5 10 5 10 5 $x=\frac{3}{7}=0.42$	+ 8 + 8 7 8 7 8 8 8 8 $x=\frac{1}{7}=0.14$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$
10	0 28 10 30 15 33 20 34 25 35 35 $x=\frac{24}{11}=2.18$	0 48 11 52 25 57 37 59 42 63 63 $x=\frac{50}{13}=3.84$	+ 10 5 10 8 11 9 11 9 11 11 $x=\frac{4}{7}=0.56$	0 + + 7 + 7 + 7 + 7 7 $x=\frac{1}{6}=0.17$	0 8 + 9 7 9 8 9 8 9 9 $x=\frac{2}{7}=0.28$	0 10 + 10 7 10 9 10 9 10 10 $x=\frac{0}{10}=0$	0 60 38 62 47 62 52 62 56 62 60 $x=\frac{28}{34}=0.82$	0 8 + 8 7 8 8 8 8 8 8 $x=\frac{1}{7}=0.14$	+ 84 30 84 58 81 72 81 80 77 84 $x=\frac{55}{22}=2.5$	0 14 + 14 11 14 13 15 14 15 14 $x=\frac{3}{12}=0.25$	+ 7 + 7 6 7 6 7 7 7 7 $x=\frac{0}{7}=0$	0 5 0 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$
12	0 7 + 8 5 8 6 9 6 10 10 $x=\frac{5}{5}=1$	0 11 + 13 5 13 8 13 10 14 14 $x=\frac{8}{6}=1.25$	+ 7 5 8 6 8 7 8 7 8 8 $x=\frac{2}{6}=0.33$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{2}{3}=0.67$	0 11 7 12 10 12 11 12 11 12 12 $x=\frac{3}{9}=0.33$	0 10 + 10 7 10 8 10 8 10 10 $x=\frac{2}{8}=0.25$	0 8 + 8 + 9 7 9 7 9 8 $x=\frac{2}{7}=0.28$	0 8 + 8 7 8 8 8 8 8 8 $x=\frac{0}{8}=0$	10 55 37 55 46 55 53 55 55 51 55 $x=\frac{33}{18}=1.83$	0 10 0 11 0 11 0 11 10 11 10 11 $x=\frac{0}{11}=0$	+ 10 8 10 10 10 10 10 10 10 10 $x=\frac{1}{9}=0.11$	0 10 0 10 + 10 8 10 10 10 10 $x=\frac{1}{9}=0.11$

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* Readings made every 24 hours for 11 days. Amount of gas produced indicated in percentages. Less than 5% is designated +. x = CO_2/H.

Blank control negative throughout.

TABLE 3.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Inulin	Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Salicin	Amygdalin	Phloridzin	Plain Carbohydrate-free Broth
B. anthracis-symptomatici											
0 5 0 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=\frac{0}{+}=0$	0 6 0 6 0 6 + 6 + 6 6 $x=\frac{0}{6}=0$	0 10 0 10 + 10 9 10 9 10 10 $x=\frac{0}{10}=0$	0 5 0 5 0 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 30 56 0 37 11 42 16 47 19 50 25 53 $x=\frac{35}{21}=1.67$	0 5 0 7 0 7 + 7 + 7 5 $x=\frac{0}{7}=0$	0 14 0 15 10 15 12 15 13 15 14 $x=\frac{2}{13}=0.15$	0 8 13 0 10 0 10 + 10 6 11 8 12 $x=\frac{3}{10}=0.3$	0 9 0 10 0 10 + 10 7 10 9 $x=\frac{0}{10}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 10 0 10 7 10 9 10 10 10 10 $x=\frac{0}{10}=0$
0 + 0 + 0 + + + + + + $x=\frac{0}{+}=0$	0 + 0 + + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 8 0 8 + 8 7 8 7 8 8 $x=\frac{0}{8}=0$	0 8 0 8 0 8 + 9 6 9 8 $x=\frac{0}{9}=0$	0 11 15 + 13 7 13 8 14 10 15 11 15 $x=\frac{4}{11}=0.36$	0 7 0 7 + 7 5 7 7 7 7 $x=\frac{0}{7}=0$	0 11 0 11 + 12 9 12 10 12 10 $x=\frac{2}{10}=0.2$	0 + 12 0 6 0 8 0 8 0 10 + 12 $x=\frac{2}{10}=0.2$	0 5 0 7 0 7 + 7 + 7 5 $x=\frac{0}{7}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 7 0 9 0 9 0 9 0 9 + $x=\frac{0}{9}=0$
0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{2}{3}=0.4$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 11 0 11 + 11 9 11 10 11 11 $x=\frac{0}{11}=0$	0 10 + 10 7 10 8 11 8 11 10 $x=\frac{3}{8}=0.38$	0 14 18 0 16 7 16 10 17 11 18 14 18 $x=\frac{4}{14}=0.29$	0 10 0 12 7 12 9 12 10 12 10 $x=\frac{2}{10}=0.2$	0 13 + 13 10 13 11 13 12 13 12 $x=\frac{2}{11}=0.18$	0 13 22 0 14 0 15 0 17 + 20 12 22 $x=\frac{4}{18}=0.22$	0 5 0 5 0 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 10 0 10 0 10 + 10 6 10 10 $x=\frac{0}{10}=0$
0 + 0 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 0 0 + 0 + 0 + 0 0 $x=\frac{0}{+}=0$	0 8 + 8 7 8 7 8 7 8 8 $x=\frac{0}{8}=0$	0 13 0 13 0 13 12 13 13 13 $x=\frac{0}{13}=0$	0 12 + 12 10 12 10 12 10 12 12 $x=\frac{1}{11}=0.09$	0 12 14 + 12 7 12 9 12 9 13 12 14 $x=\frac{4}{10}=0.4$	0 7 0 7 + 7 5 7 7 7 7 $x=\frac{0}{7}=0$	0 15 0 15 7 15 13 15 14 15 14 $x=\frac{1}{14}=0.07$	0 0 13 0 5 0 5 0 11 0 12 0 13 $x=\frac{0}{13}=0$	0 7 0 8 0 8 + 8 + 8 7 $x=\frac{0}{8}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 7 0 10 0 10 0 10 0 $x=\frac{0}{10}=0$
0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 7 + 7 5 7 6 7 7 7 7 $x=\frac{1}{6}=0.17$	0 17 + 17 14 17 14 17 15 17 17 $x=\frac{2}{15}=0.13$	0 9 0 9 0 9 0 9 0 9 0 $x=\frac{0}{9}=0$	0 8 0 8 0 8 5 8 7 8 8 $x=\frac{1}{7}=0.14$	0 20 33 0 23 10 25 15 28 16 31 18 32 $x=\frac{13}{20}=0.65$	0 8 0 10 7 10 7 10 8 10 8 $x=\frac{1}{9}=0.11$	0 11 0 11 0 12 0 12 6 12 11 $x=\frac{0}{12}=0$	0 0 5 0 0 0 0 0 + 0 + 0 5 $x=\frac{0}{5}=0$	0 + 0 5 0 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	+ 14 8 14 13 14 14 14 14 14 14 $x=\frac{0}{14}=0$
0 + 0 + + + + + + + + $x=\frac{0}{+}=0$	0 + 0 + + + + + + + + 5 $x=\frac{0}{5}=0$	0 8 + 8 + 8 7 8 8 8 8 $x=\frac{1}{7}=0.14$	0 10 0 11 0 11 0 11 0 11 8 $x=\frac{0}{11}=0$	0 6 0 6 + 6 + 6 5 6 6 $x=\frac{0}{6}=0$	0 25 35 0 30 12 30 15 32 18 33 23 34 $x=\frac{14}{21}=0.67$	0 9 0 10 7 10 8 10 9 10 9 $x=\frac{1}{9}=0.11$	10 76 85 76 83 75 78 72 75 72 78 $x=\frac{19}{53}=0.36$	0 35 42 0 38 30 40 33 40 33 41 35 42 $x=\frac{19}{23}=0.82$	0 + 0 + 0 + + 5 + 5 + $x=\frac{0}{5}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 13 0 13 + 13 8 13 11 13 13 $x=\frac{0}{13}=0$
0 0 0 + 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 + 0 + 0 + 0 + 0 + + $x=\frac{0}{+}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 8 0 9 0 9 0 9 8 9 8 $x=\frac{0}{9}=0$	0 11 0 11 8 11 8 11 10 11 11 $x=\frac{1}{10}=0.1$	0 25 31 0 28 15 28 17 30 19 31 23 31 $x=\frac{9}{22}=0.4$	0 5 0 6 + 6 + 6 5 6 5 $x=\frac{0}{6}=0$	0 8 0 8 + 8 7 8 8 8 8 $x=\frac{0}{8}=0$	0 23 27 0 25 0 25 + 25 13 26 20 27 $x=\frac{4}{23}=0.17$	0 6 0 6 0 6 + 6 + 6 + $x=\frac{0}{6}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$

TABLE 3.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Strain	Dextrose	Levulose	Galactose	Arabinose	Mannose	Rhamnose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin
	B. anthracis-symptomatici											
48	+ 28 7 32 11 35 15 40 18 41 25 41 $x=\frac{32}{9}=3.55$	0 24 + 26 8 26 14 28 18 28 21 $x=\frac{20}{8}=2.5$	+ 9 5 9 6 10 8 10 8 10 10 $x=\frac{1}{9}=0.11$	0 5 + 5 + 5 + 5 + 5 5 5 $x=\frac{2}{3}=0.67$	0 10 + 10 5 12 8 12 8 12 9 $x=\frac{3}{9}=0.33$	0 7 + 7 5 7 7 7 7 7 7 $x=\frac{0}{7}=0$	0 19 10 20 13 20 15 20 17 20 19 $x=\frac{7}{13}=0.53$	0 5 + 5 + 5 5 5 5 5 5 $x=\frac{0}{5}=0$	+ 43 10 47 15 50 23 54 28 54 37 $x=\frac{41}{13}=3.15$	0 8 + 8 6 8 6 8 6 8 6 $x=\frac{1}{7}=0.14$	0 11 0 11 0 11 0 11 0 11 10 $x=\frac{1}{10}=0.1$	0 8 + 8 7 8 7 8 7 8 7 $x=\frac{1}{7}=0.14$
60	+ 43 8 48 13 52 18 53 25 53 35 $x=\frac{43}{10}=4.3$	10 74 18 75 28 73 43 73 53 70 67 $x=\frac{58}{12}=4.8$	+ 8 5 8 6 8 7 8 7 8 8 $x=\frac{3}{5}=0.6$	0 + + + + + + + + 5 + $x=\frac{1}{4}=0.25$	0 7 + 7 + 7 5 7 5 7 6 $x=\frac{1}{6}=0.17$	0 5 + 6 + 6 5 6 5 6 5 $x=\frac{1}{5}=0.2$	0 10 + 10 5 10 7 10 9 10 9 $x=\frac{3}{7}=0.42$	0 5 + 7 + 7 + 7 + 7 + $x=\frac{0}{7}=0$	5 75 14 77 35 77 54 77 65 75 72 $x=\frac{57}{18}=3.16$	0 11 0 11 8 11 10 11 10 11 11 $x=\frac{2}{9}=0.22$	+ 5 + 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	0 + 0 + + + + + + + + $x=\frac{0}{+}=0$
	Ghon-Sachs bacillus I											
	0 12 0 17 + 20 + 23 7 24 24 $x=\frac{8}{16}=0.5$	0 + 0 5 0 7 + 10 + 10 + $x=\frac{3}{7}=0.42$	0 15 0 18 0 21 + 25 7 28 12 $x=\frac{8}{20}=0.4$	0 5 0 5 0 5 + 6 + 6 5 $x=\frac{0}{6}=0$	0 0 0 0 0 0 0 0 0 0 .... x=—=0	0 33 0 33 25 33 30 32 32 32 33 $x=\frac{12}{20}=0.6$	0 + 0 + 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 0 0 0 0 9 0 13 0 15 0 $x=\frac{2}{13}=0.15$	0 20 + 20 5 20 8 24 13 24 16 $x=\frac{6}{18}=0.33$	0 8 0 8 + 8 + 8 7 8 7 $x=\frac{0}{8}=0$	0 10 0 10 + 10 7 10 8 10 8 $x=\frac{0}{10}=0$	0 + 0 + 0 5 0 5 0 5 + $x=\frac{0}{5}=0$
	B. oedematis-maligni, I											
421	10 28 15 30 18 30 21 31 24 31 25 $x=\frac{21}{10}=2.1$	0 14 + 15 8 15 11 15 12 15 13 $x=\frac{10}{5}=2$	+ 10 6 10 7 10 8 10 8 10 8 $x=\frac{3}{7}=0.42$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	+ 13 + 13 7 13 9 13 10 13 12 $x=\frac{4}{9}=0.44$	0 7 + 7 + 7 5 7 7 7 7 $x=\frac{1}{6}=0.17$	0 10 + 10 + 11 6 11 7 11 7 $x=\frac{4}{7}=0.57$	+ 7 5 7 6 7 6 7 6 7 6 $x=\frac{1}{6}=0.17$	35 71 60 71 70 69 75 69 73 65 71 $x=\frac{13}{52}=0.25$	0 13 + 14 9 14 10 15 12 15 13 $x=\frac{4}{11}=0.36$	+ 8 5 8 7 8 7 8 7 8 7 $x=\frac{1}{7}=0.14$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{0}{5}=0$
485	+ 22 12 23 15 23 17 24 18 24 20 $x=\frac{14}{10}=1.4$	0 19 + 20 10 20 14 20 16 20 18 $x=\frac{11}{9}=1.2$	+ 10 7 10 8 11 10 11 10 11 10 $x=\frac{2}{9}=0.22$	0 8 + 8 5 8 7 8 7 8 7 $x=\frac{1}{7}=0.14$	0 13 8 13 10 13 12 13 12 13 13 $x=\frac{2}{11}=0.18$	0 11 7 11 9 11 9 11 10 11 11 $x=\frac{1}{10}=0.1$	0 13 7 13 8 13 10 13 12 13 12 $x=\frac{4}{9}=0.44$	+ 10 8 10 9 10 10 10 10 10 10 $x=\frac{0}{10}=0$	+ 55 35 55 48 55 57 55 56 50 56 $x=\frac{33}{17}=1.94$	0 13 + 13 9 13 10 13 11 13 11 $x=\frac{3}{10}=0.3$	0 14 0 14 0 14 8 15 12 15 13 $x=\frac{2}{13}=0.15$	0 + 0 + + + + + + + + $x=\frac{0}{+}=0$
558	+ 17 8 18 10 20 13 20 14 20 15 $x=\frac{12}{8}=1.5$	0 12 + 13 5 13 8 14 9 14 10 $x=\frac{9}{5}=1.8$	0 5 + 5 + 6 5 6 5 6 5 $x=\frac{0}{6}=0$	0 + + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 15 11 15 13 15 14 15 14 15 15 $x=\frac{3}{12}=0.25$	+ 12 10 12 10 12 11 12 11 12 11 $x=\frac{0}{12}=0$	0 7 + 8 + 8 6 8 7 8 7 $x=\frac{2}{6}=0.33$	0 8 5 8 6 8 7 8 7 8 7 $x=\frac{1}{7}=0.14$	13 72 42 71 58 71 68 71 70 69 70 $x=\frac{51}{18}=2.83$	0 12 + 13 10 13 10 13 10 13 12 $x=\frac{2}{11}=0.18$	+ 10 + 10 + 10 10 10 10 10 10 $x=\frac{0}{10}=0$	+ 6 5 6 5 6 5 6 6 6 6 $x=\frac{0}{6}=0$

TABLE 3.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Inulin	Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Salicin	Amygdalin	Phlorizin	Plain Carbohydrate-free Broth
B. anthracis-symptomatici											
0 6 + 7 6 7 6 7 6 7 6 $x=\frac{0}{7}=0$	0 8 0 8 0 8 5 8 7 8 7 $x=\frac{4}{4}=1$	0 8 0 8 + 8 7 8 8 8 8 $x=\frac{0}{8}=0$	0 8 0 8 0 8 + 8 7 8 8 $x=\frac{0}{8}=0$	+ 6 + 6 5 6 5 6 5 6 6 $x=\frac{0}{6}=0$	+ 43 68 12 51 14 57 15 62 18 64 35 66 $x=\frac{47}{21}=2.24$	0 9 0 10 8 10 8 10 9 10 9 $x=\frac{1}{9}=0.11$	0 8 + 8 + 8 7 8 7 8 7 $x=\frac{0}{8}=0$	0 17 25 0 20 0 21 + 21 10 23 16 25 $x=\frac{5}{20}=0.25$	0 10 0 12 0 12 6 12 9 12 10 $x=\frac{0}{12}=0$	0 + 0 + 0 + 0 + + + + $x=\frac{0}{+}=0$	0 10 0 12 0 12 0 12 8 12 10 $x=\frac{0}{12}=0$
0 4 0 4 + 4 + 4 + 4 + $x=\frac{0}{4}=0$	0 + 0 + 0 + 0 + 0 + + $x=\frac{0}{+}=0$	0 7 0 8 + 8 5 8 7 8 7 $x=\frac{0}{8}=0$	0 10 0 10 0 10 + 10 9 10 10 $x=\frac{0}{10}=0$	0 + 0 + + 6 + 6 + 6 + $x=\frac{0}{6}=0$	0 18 26 0 20 10 22 12 23 13 25 16 26 $x=\frac{8}{18}=0.44$	0 6 0 6 + 6 + 6 + 6 6 $x=\frac{0}{6}=0$	0 10 0 12 + 12 10 12 10 12 10 $x=\frac{1}{11}=0.09$	0 0 5 0 0 0 0 0 0 0 + 0 5 $x=\frac{0}{5}=0$	0 5 0 5 0 7 + 7 + 7 5 7 $x=\frac{0}{7}=0$	0 0 0 0 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 7 0 7 0 7 + 7 5 7 5 $x=\frac{0}{7}=0$
Ghon-Sachs bacillus I											
0 9 0 10 + 10 7 10 7 10 9 $x=\frac{0}{10}=0$	0 10 0 10 0 10 + 10 9 10 9 $x=\frac{0}{10}=0$	0 + 0 + 0 + + + + + + $x=\frac{0}{+}=0$	0 + 0 + 0 + 0 + + + + $x=\frac{0}{+}=0$	0 12 0 12 0 12 + 12 11 12 12 $x=\frac{0}{12}=0$	0 0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 92 70 92 77 92 82 87 85 87 92 $x=\frac{27}{60}=0.45$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 + 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 0 0 0 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$
B. oedematis-maligni, I											
0 + 0 5 0 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 7 + 7 + 7 + 7 5 7 5 $x=\frac{1}{6}=0.17$	0 17 15 17 17 17 17 17 17 17 17 $x=\frac{1}{16}=0.06$	0 + 0 8 0 8 0 8 0 8 0 $x=\frac{0}{8}=0$	0 11 0 11 7 11 9 11 9 11 11 $x=\frac{1}{10}=0.1$	0 12 24 0 15 0 16 0 18 6 20 11 22 $x=\frac{6}{18}=0.33$	0 16 0 17 8 17 13 17 14 17 16 $x=\frac{2}{15}=0.13$	0 7 0 8 0 8 0 8 + 8 + $x=\frac{0}{8}=0$	0 11 19 0 13 0 15 0 15 + 17 9 19 $x=\frac{0}{19}=0$	0 5 0 6 0 6 + 6 + 6 + $x=\frac{0}{6}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 15 0 15 0 15 + 15 13 15 15 $x=\frac{0}{15}=0$
0 5 0 7 5 7 5 7 5 7 5 $x=\frac{0}{7}=0$	0 5 0 5 0 5 0 5 0 5 + $x=\frac{1}{4}=0.25$	0 5 0 5 0 5 0 5 + 5 5 $x=\frac{0}{5}=0$	0 25 0 28 0 28 14 28 20 27 24 $x=\frac{11}{16}=0.69$	0 8 + 8 7 8 7 8 7 8 8 $x=\frac{1}{7}=0.14$	0 43 60 0 51 18 55 23 57 25 59 33 60 $x=\frac{32}{28}=1.14$	+ 11 10 12 10 12 10 12 10 12 11 $x=\frac{2}{10}=0.2$	0 10 + 12 + 12 8 12 9 12 10 $x=\frac{2}{10}=0.2$	0 19 31 0 23 0 25 + 25 9 27 15 29 $x=\frac{3}{28}=0.11$	0 11 0 11 + 12 8 12 10 12 11 $x=\frac{0}{12}=0$	0 0 0 0 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 10 0 11 0 11 8 11 10 11 10 $x=\frac{0}{11}=0$
0 + 0 + + + + + + + + $x=\frac{0}{+}=0$	0 + 0 + 0 + + 7 + 7 + $x=\frac{1}{6}=0.17$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 8 0 9 + 9 6 9 6 9 8 $x=\frac{0}{9}=0$	0 + 0 5 0 5 0 5 0 5 + $x=\frac{0}{5}=0$	8 21 26 18 22 19 23 19 23 19 25 20 26 $x=\frac{8}{18}=0.44$	0 11 + 11 10 11 10 11 10 11 11 $x=\frac{1}{10}=0.1$	0 7 0 8 + 8 + 8 5 8 7 $x=\frac{0}{8}=0$	0 30 33 + 32 12 32 25 32 26 33 29 33 $x=\frac{8}{25}=0.32$	0 10 0 10 0 10 + 10 8 10 8 $x=\frac{0}{10}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 13 0 13 8 13 13 13 13 13 13 $x=\frac{0}{13}=0$

TABLE 3.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Strain	Dextrose	Levulose	Galactose	Arabinose	Mannose	Rhamnose	Xylose	Lactose	Maltose	Saccharose	Raffinose	Dextrin
B. oedematis-maligni, I												
560	0 7 + 7 + 8 5 8 5 8 6 $x=\frac{5}{3}=1.67$	0 17 + 18 5 18 10 20 13 20 15 $x=\frac{15}{5}=3$	0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 + + + + 4 + 4 + 4 + $x=\frac{1}{3}=0.33$	0 11 + 13 5 13 7 14 8 14 10 $x=\frac{4}{10}=0.4$	0 8 + 8 + 8 7 8 8 8 8 $x=\frac{0}{8}=0$	0 7 + 7 + 7 + 7 5 7 5 $x=\frac{1}{6}=0.17$	0 10 7 10 10 10 10 13 10 13 10 $x=\frac{3}{10}=0.3$	+ 18 10 18 13 19 15 19 15 19 17 $x=\frac{14}{5}=2.8$	0 23 + 24 10 25 13 28 17 28 20 $x=\frac{10}{18}=0.55$	+ 10 + 10 9 10 10 10 10 10 10 $x=\frac{2}{8}=0.25$	0 + + + + + + + + + + $x=\frac{0}{+}=0$
B. oedematis-maligni, II, (Novy 1-ME II)												
	0 15 + 16 8 16 11 16 13 16 15 $x=\frac{12}{4}=3$	0 12 + 14 + 15 7 16 7 16 10 $x=\frac{9}{7}=1.3$	0 8 + 8 6 8 7 8 7 8 7 $x=\frac{2}{6}=0.33$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{2}{3}=0.67$	0 0 0 4 0 4 0 4 0 4 0 $x=\frac{1}{3}=0.33$	0 8 0 8 + 8 + 8 7 8 8 $x=\frac{0}{8}=0$	0 6 0 8 + 8 5 8 6 8 6 $x=\frac{2}{6}=0.33$	0 6 + 6 5 6 5 6 6 6 6 $x=\frac{0}{6}=0$	0 26 8 26 15 27 20 27 23 27 25 $x=\frac{21}{6}=3.5$	0 + + 5 + 5 + 5 + 5 + $x=\frac{1}{4}=0.25$	0 6 + 6 + 6 + 6 + 6 + $x=\frac{1}{5}=0.2$	0 5 0 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$
B. botulinus												
	0 13 5 14 8 14 10 14 10 14 12 $x=\frac{9}{5}=1.8$	0 12 + 14 + 14 5 15 8 15 10 $x=\frac{10}{5}=2$	0 5 + 5 + 5 + 5 5 5 5 $x=\frac{1}{4}=0.25$	0 5 + 5 + 5 + 6 + 6 5 $x=\frac{0}{6}=0$	0 6 + 6 + 6 5 6 5 6 5 $x=\frac{0}{6}=0$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 8 + 8 + 8 5 8 7 8 7 $x=\frac{2}{6}=0.33$	0 7 + 7 + 7 5 7 5 7 5 $x=\frac{1}{6}=0.17$	0 15 + 17 8 19 10 19 12 19 13 $x=\frac{11}{8}=1.37$	0 10 + 10 6 10 7 10 8 10 8 $x=\frac{2}{8}=0.25$	+ 5 + 5 5 5 5 5 5 5 5 $x=\frac{0}{5}=0$	0 7 0 7 + 7 + 7 6 7 6 $x=\frac{0}{7}=0$
B. coli (control)												
	33 55 48 56 51 58 55 60 55 63 55 $x=\frac{30}{33}=0.90$	67 70 70 71 71 71 73 72 70 72 70 $x=\frac{30}{42}=0.71$	8 61 30 65 38 67 48 70 53 72 58 $x=\frac{44}{28}=1.57$	60 78 72 77 78 75 80 75 78 72 78 $x=\frac{27}{45}=0.6$	70 68 71 68 71 68 72 68 70 68 68 $x=\frac{28}{40}=0.7$	20 50 40 52 45 52 48 50 48 50 50 $x=\frac{20}{30}=0.67$	37 75 65 80 70 77 73 73 72 73 75 $x=\frac{26}{47}=0.55$	65 77 73 77 76 75 78 75 77 75 77 $x=\frac{35}{40}=0.9$	28 83 63 80 70 78 83 75 87 73 87 $x=\frac{41}{32}=1.28$	45 88 62 90 75 90 85 90 88 90 88 $x=\frac{48}{42}=1.14$	42 90 75 90 90 88 90 88 90 88 90 $x=\frac{48}{40}=1.2$	0 5 + 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$

TABLE 3.—*Continued*

COMPARISON OF RESULTS IN GAS-PRODUCTION FROM SUGARS BY BACILLUS ANTHRACIS-SYMPTOMATICI AND ALLIED ORGANISMS *

Inulin	Glycogen	Starch	Glycerin	Adonite	Sorbite	Dulcite	Mannite	Salicin	Amygdalin	Phloridzin	Plain Carbohydrate-free Broth
B. oedematis-maligni, I											
0 6 0 7 + 7 + 7 + 7 6 $x=\frac{1}{6}=0.17$	0 7 + 7 + 7 + 7 + 7 + $x=\frac{0}{7}=0$	0 8 + 8 5 8 5 8 8 8 8 $x=\frac{0}{8}=0$	0 32 + 34 20 34 25 37 28 37 30 $x=\frac{11}{26}=0.42$	0 5 0 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 14 20 + 17 6 17 10 17 12 19 14 20 $x=\frac{8}{12}=0.67$	0 5 0 5 + 5 + 5 + 5 5 $x=\frac{0}{5}=0$	0 7 0 9 + 9 5 9 7 9 7 $x=\frac{0}{9}=0$	0 5 8 0 5 0 5 + 7 + 8 5 8 $x=\frac{0}{8}=0$	0 5 0 7 0 7 + 7 + 7 + $x=\frac{0}{7}=0$	0 0 0 0 0 + 0 + 0 + 0 $x=\frac{0}{+}=0$	0 8 0 8 + 8 + 8 6 8 6 $x=\frac{0}{8}=0$
B. oedematis-maligni, II, (Novy 1-ME II)											
0 7 0 7 + 7 + 7 + 7 7 $x=\frac{0}{7}=0$	0 + 0 + 0 + + + + + + $x=\frac{0}{+}=0$	0 7 5 7 5 7 7 7 7 7 7 $x=\frac{0}{7}=0$	0 30 0 35 + 40 13 43 19 43 24 $x=\frac{16}{27}=0.6$	0 7 0 7 0 7 + 7 + 7 7 $x=\frac{0}{7}=0$	0 12 15 + 13 8 13 9 13 10 14 12 15 $x=\frac{5}{10}=0.5$	0 8 0 8 + 9 5 9 8 9 8 $x=\frac{0}{9}=0$	0 10 0 10 + 10 7 10 8 10 8 $x=\frac{1}{9}=0.11$	0 5 10 0 8 0 8 + 8 + 9 5 10 $x=\frac{0}{10}=0$	0 9 0 10 0 10 + 10 8 10 9 $x=\frac{0}{10}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 6 0 7 + 7 + 7 + 7 6 $x=\frac{0}{7}=0$
B. botulinus											
0 + 0 + + + + + + + + $x=\frac{0}{+}=0$	0 + + + + + + + + + + $x=\frac{0}{+}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 22 0 23 10 25 15 28 17 28 20 $x=\frac{10}{18}=0.55$	0 + 0 6 0 6 + 6 + 6 + $x=\frac{0}{6}=0$	0 13 23 + 15 8 17 10 19 11 21 13 23 $x=\frac{11}{12}=0.92$	0 5 0 6 + 6 + 6 5 6 5 $x=\frac{0}{6}=0$	0 10 0 10 + 10 8 10 9 10 9 $x=\frac{1}{9}=0.11$	0 5 8 0 7 0 7 + 7 + 8 + 8 $x=\frac{0}{8}=0$	0 8 0 9 0 9 + 9 5 9 7 $x=\frac{0}{9}=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 10 0 10 + 10 5 10 8 10 8 $x=\frac{0}{10}=0$
B. coli (control)											
0 + 0 + + + + + + + + $x=\frac{0}{+}=0$	0 5 + 5 + 5 + 5 + 5 + $x=\frac{0}{5}=0$	0 18 0 38 0 47 0 50 + 50 7 $x=\frac{11}{39}=0.26$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	64 83 90 84 90 81 87 77 82 77 83 $x=\frac{20}{57}=0.35$	0 95 65 95 90 95 92 90 92 90 95 $x=\frac{25}{65}=0.38$	50 73 75 75 76 73 75 73 71 73 73 $x=\frac{23}{50}=1.46$	0 51 0 52 35 52 48 50 48 50 51 $x=\frac{15}{35}=0.42$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 0 0 0 0 0 0 0 0 0 0 $x=0$	0 7 0 7 + 7 5 7 7 7 7 $x=\frac{0}{7}=0$

TABLE 4

SUMMARIZED READINGS TAKEN FROM TABLE 3

		Dextrose		Levulose		Mannose		Maltose		Saccharose	
		CO_2	H	CO_2	H	CO_2	H	CO_2	H	CO_2	H
B. anthracis-symptomatici	2	15	15	49	20	4	10	36	12	0	5
	3	40	12	50	12	8	14	37	13	2	9
	4	40	20	36	14	4	5	43	22	2	10
	5	23	19	21	13	2	8	28	18	3	12
	6	42	13	54	22	3	10	44	17	3	7
	10	24	9	50	13	2	7	55	22	3	12
	12	5	5	8	6	3	9	33	18	0	11
	48	32	8	20	8	3	9	41	13	1	7
	60	43	10	58	12	1	6	57	18	2	9
Total		264	102	346	120	30	78	374	153	16	84
Average		29.3	11.3	38.4	13.3	3.3	8.4	41.6	17	1.8	9.3
Average total gas		40.6		51.7		11.7		58.6		11.1	
CO_2/H		2.59		2.9		0.39		2.56		0.19	
Ghon-Sachs bacillus		8	16	3	7	0	0	6	18	0	8
Total gas		24		10		0		24		8	
CO_2/H		0.5		0.42		0		0.33		0	
B. oedematis-maligni	421	21	10	10	5	4	9	13	52	4	11
	485	14	10	11	9	2	10	33	17	3	10
	558	12	8	9	5	3	12	51	18	2	11
	560	5	3	15	5	4	10	14	5	10	18
Total		52	31	45	24	14	41	111	92	19	50
Average		13	7.8	11.3	6	3.3	10.3	27.8	23	4.8	12.5
Average total gas		20.8		17.3		13.6		50.8		17.3	
CO_2/H		1.68		1.88		0.32		1.2		0.38	
B. oedematis-maligni II		12	4	9	7	1	3	21	6	1	4
Total gas		16		16		4		27		5	
CO_2/H		3.0		1.3		0.33		3.5		0.25	
B. botulinus		9	5	10	5	0	6	11	8	2	8
Total gas		14		15		6		19		10	
CO_2/H		1.8		2.0		0		1.38		0.25	
B. coli		30	33	30	42	28	40	41	32	48	42
Total gas		63		72		68		73		90	
CO_2/H		0.97		0.71		0.70		1.28		1.14	

the broth, as is shown in the tables. This suggests the influence that training of the stock cultures may have on the gas-producing characteristic.

Our results thus far show that the minor sugars, etc., are of little value in the differentiation of the strains on the basis of total production of gas. Strains of the same organism obtained from various sources differ from one another considerably in their ability to attack the several carbohydrates and form gas from them. Again, some strains produce a certain amount of carbon dioxid while others produce none. Both these factors vary somewhat from experiment to experiment in the carbohydrate media with which only small amounts of gas are produced.

A study of the coefficients obtained with the carbohyrates from which the larger amounts of gas are formed — that is, dextrose, levu-

TABLE 4.—*Continued*

SUMMARIZED READINGS TAKEN FROM TABLE 3

Glycerin		Sorbite		Salicin		General Average			
CO_2	H	CO_2	H	CO_2	H	Av. Total	CO_2	H	CO_2/H
0	10	35	21	3	10	30.7	17.8	12.9	1.38
0	8	4	11	2	10	29.0	17.9	11.1	1.60
0	11	4	14	4	18	30.9	16.6	14.3	1.17
0	13	4	10	0	13	22.2	10.1	12.1	0.84
0	9	13	20	0	5	32.8	19.9	12.9	1.54
0	11	14	21	19	23	34.4	18.4	16.0	1.15
0	9	9	22	4	23	20.7	7.8	12.9	0.60
0	8	47	21	5	20	30.4	18.6	11.8	1.57
0	10	8	18	0	5	32.1	21.1	11.0	1.92
0	89	138	158	37	127				
0	9.9	15.4	17.6	4.1	14.1	29.4	16.7	12.7	1.32
9.9		33		18.2					
0.0		0.9		0.28					
0	+	0	0	0	0	8.6	2.1	6.5	0.33
+		0		0					
0		0		0					
0	8	6	18	0	19	23.8	7.3	16.5	0.44
11	16	32	28	3	28	29.6	13.6	16.0	0.85
0	9	8	18	8	25	24.9	11.6	13.3	0.88
11	26	8	12	0	8	19.3	8.4	10.9	0.77
22	59	54	76	11	80				
5.5	14.8	13.5	19	2.8	20	24.4	10.2	14.2	0.72
20.3		32.5		22.8					
0.37		0.71		0.14					
16	27	5	10	0	10	17.0	8.1	8.9	0.92
43		15		10					
0.60		0.50		0					
10	18	11	12	0	8	15.6	6.6	9.0	0.76
28		23		8					
0.55		0.92		0					
0	0	20	57	15	35	61.6	26.5	35.1	0.76
0		77		50					
0		0.35		0.42					

lose, mannose, maltose, saccharose, glycerin, sorbite, and salicin — shows several interesting results. In general it may be said that the malignant-edema strains produce less total gas, with a smaller proportion of carbon dioxid, than is produced by the symptomatic-anthrax strains. The Ghon-Sachs bacillus produces only a small amount of carbon dioxid — with most sugars, none at all.

With dextrose, levulose, and maltose, symptomatic-anthrax strains produce much the greater amount of gas, a major part of which is carbon dioxid.

With glycerin, symptomatic-anthrax strains produce no carbon dioxid at all, while malignant edema strains do. The latter also produce twice as much gas in this medium.

Malignant-edema-II strains, tho producing a smaller amount of gas, produce a greater proportion of carbon dioxid than Malignant-edema-I strains.

The gas shrinkage, especially in the gas of B. coli, as suggested by Keyes,[5] would seem to be largely due to the diffusion of the more soluble carbon dioxid through the liquid to the open arm where the concentration is nearly zero. He finds that cultures of B. coli in a vacuum apparatus show a large amount of gas and a larger proportion of carbon dioxid than do cultures of the same organism in ordinary fermentation tubes. Since the action of B. coli is over in a comparatively short time and the collected gas stands for several days, there must be considerable loss by diffusion.

None of the 9 strains of the bacillus of symptomatic anthrax produced more hydrogen than carbon dioxid with dextrose. With this sugar, an average coefficient CO_2/H of 2.59 was obtained, a result contradicting the statement of Franklin and Haslam,[6] that blackleg always produces more hydrogen than carbon dioxid with this sugar. It is not stated in their communication at what stage in the fermentation the gas was analyzed; a premature reading, such as one 72 hours after inoculation, would give a different carbon-dioxid factor from that obtained at the end of gas-production. Also the arbitrary use of a 4% sugar medium may have had some influence on the factors obtained.

Emphasis has frequently been placed on the characteristic odor of

TABLE 5

Results of Tests for Substances Giving Rise to Characteristic Putrid Odors in Cultures

Strain No.		Hydrogen Sulfid	Methyl Mercaptan	Indol
B. anthracis-symptomatici	2	+	+	+++
	3	+	+	++
	4	+	+	++
	5	+	+	++
	6	+	—	++
	10	+	—	+
	12	+	+ (faint)	+
	48	+	+ (faint)	+
	60	+	+	+
Ghon-Sachs bacillus	1	—	—	±
B. oedematis-maligni	421	+	+	±
	485	+	+	++
	558	+	+	++
	560	+	+	++
B. oedematis-maligni, II		+	+	+
B. botulinus		+	..	+
B. coli		—	±	+++
B. proteus		+	+ (faint)	+
Blank control		—	—	—

Tests used: for hydrogen sulfid, the lead acetate test: for methyl mercaptan, the isatin test[7]; for indol, Salkowski's reaction.

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[5] Jour. Med. Research, 1909, 16, p. 73.

[6] Franklin and Haslam, Jour. Infect. Dis., 1916, 19; p. 462.

[7] Bauer, Ztschr. f. physiol. Chem., 1902, 35, p. 346.

symptomatic-anthrax cultures as a means of differentiating them from those of malignant edema.[8, 4] The general opinion is that cultures of symptomatic anthrax are of an aromatic acid odor, particularly like that of butyric acid, while those of malignant edema are of a vile putrid odor. The results of the olfactory test on our cultures agree with this general opinion when applied to young cultures, but with old cultures the reverse obtains. However, tests made for the substances credited with the production of the vile odor — indol, hydrogen sulfid, and methyl mercaptan — show that strain members of both the symptomatic-anthrax and malignant-edema groups originate these substances.

SUMMARY

B. anthracis-symptomatici produces more gas from dextrose, levulose, and maltose than B. oedematis-maligni, and a greater proportion of this is carbon dioxid. This is illustrated in the following summarized table (averages for 9 strains of B. anthracis-symptomatici, and for 4 strains of B. oedematis-maligni).

	Dextrose	Levulose	Maltose	Average
B. anthracis-symptomatici				
CO_2	29.30	38.4	41.60	36.40
H	11.30	13.3	17.00	13.90
Total gas	40.60	51.7	58.60	50.30
CO_2/H	2.59	2.9	2.56	2.65
B. oedematis-maligni				
CO_2	13.00	11.30	27.8	17.80
H	7.80	6.00	23.0	12.80
Total gas	20.80	17.30	50.8	29.60
CO_2/H	1.68	1.88	1.2	1.41

Training of seed cultures influences the gas-production of these organisms considerably.

Substances credited with the putrid odor are produced in cultures by strain members of both groups.

The gas-production of most of the strains occurs late and progressively up to about the 10th day. In some media, gas-production continues to a slight degree for some time after this.

An explosive mixture of gases, apparently containing hydrogen and no carbon dioxid, may be produced from "carbohydrate-free" broth.

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[8] von Hibler, Handb. d. pathogen. Mikroorganismen, 1912, 4, p. 808. Hiss and Zinsser, Bacteriology, p. 470.